AN ARTIFICIAL HEAD WITH REMOVABLE PINNAE

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Artificial heads have been fabricated in the past to fill various needs. In the last decade two unique models, among others, have been described in the literature for use in specific areas of research.

Nordlund and Liden (1) utilized an interesting technique by covering a human cranium with plastic material. The outer ears and other features were made of a soft material ". . . simulating human flesh." The authors wrote that the ". . . head . . . is anatomically similar to an average human head." The shortcoming in this article, at least for those involved in prosthetics, is the fact that these authors neglect the discussion concerning the exact materials used, the problems they may have encountered, and how the material was applied to the cranium, etc.

Another model of the human head was made by Mr. J. Coppolino, VA Prosthetics Center, New York. This head was used in several studies, most notably, Kasten and Lotterman (2) and Simon (3).

Coppolino's model was developed from a life mask with a core of hard plastic. This was covered by a layer of vinyl plastisol which reasonably simulated the acoustic properties of the human head.

The specific research areas that motivated the fabrication of the two head models differed. Hence, slight differences in the ears appeared in the two models. Nordlund's head contained two condensor microphones placed in the location of the eardrums. There is no mention of how the pinnae and the ear canals were formed. This model was used in studies concerned with directional hearing of various frequencies and speech signals directed to the head from various angles. The Coppolino model utilized two acoustic couplers, the outer face of which ". . . approximated the position of the outer face of an earmold as worn by a hearing-aid user (2)." Here, also, the research is focused on azimuth effects (head-shadow effects), but with the use of various types of hearing aids.

The artificial head with which we are concerned was motivated by

research of a different sort. The research, instituted by the Audiology and Speech Pathology Service, VAOCI, Philadelphia, is directed to ascertain the role of a pinna in the perception of speech. We were not concerned with the role of a pinna as it relates to localization, for there are many such articles, such as Fisher and Freedman (4), in the literature. Our research demanded that the model which we used have the following unique characteristics: 1. microphone diaphragms in the exact location of the tympanic membranes, 2. reproduction in plastic of the pinnae and the ear canals as close to realistic as possible, and 3. removable pinnae. This last requirement was necessary, for the investigators wished to present to the head speech signals from different angles with and without the pinnae in place. In this way the recorded product could be analyzed and comparisons made.

The life-size head model was made by the two members of the Restoration Service, VAOCI, Philadelphia. The head was sculpted without the pinnae in plastiline over a standard-sized, egg-shaped styrofoam wig-mount. A negative stone three-piece mold was then formed from the sculpted head. Six layers of vinyl plastisol were then slushed into the negative mold. To the first and second slushing a flesh-colored pigment was added to simulate a skin tone and texture. Small patches of light nylon netting were used to reinforce the vinyl plastisol at points of stress. The resultant "positive" of the head was placed over a hollow core of dental stone which was approximately 1 in. thick.

The pinnae and ear canals for the model were made by direct impression from a live subject. Standard impression materials were used and the canal impressions were extremely deep. The direct impression method was used to simulate the real-life positions and convolutions of the pinnae and canals. The completed pinnae and canals were made with the same materials as the head. The canals were placed in the head at the appropriate positions and angles.

A square portion of the head was removed from the base of the skull. This penetration into the "cranial" opening permitted a better perspective for placement of the canals. Figure 1 depicts the model with the square portion removed. Several attempts had been made to position the canals through the base of the neck, but this proved to be inadvisable.

Microphones (10 ohm TDH 39), without the usual cushions, were then placed inside the head. The diaphragms of the microphones were positioned against the end of the canals to simulate the position of the tympanic membrane. The microphones were held in place with metal clips which had been embedded into the inside surface of the hollow core. Figure 1 also illustrates the microphone positions in the head and the patch cords exiting through posterior base of the neck.

The cutout portion of the head was then replaced by cementing the stone edges together. The vinyl plastisol edges were reattached with

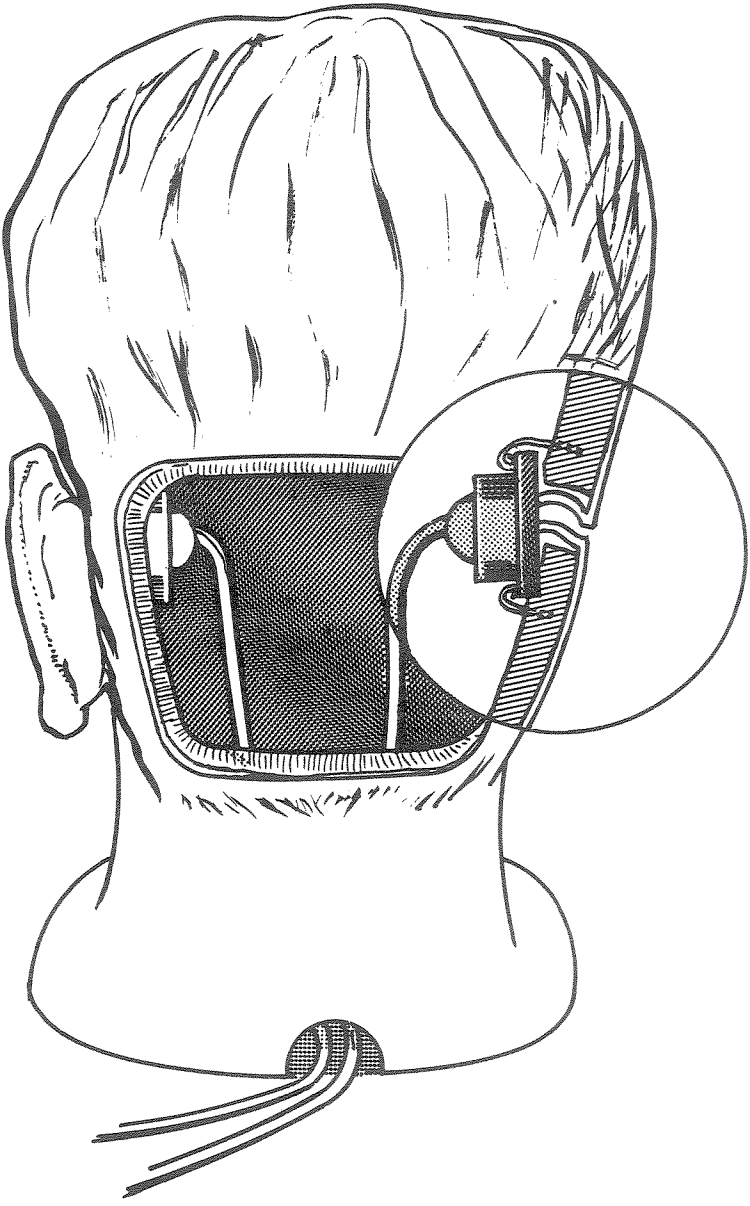

FIGURE 1

Cordo, a clear vinyl plastisol coating. This portion of the head can be removed at anytime for repair or replacement of the microphones and/or cords.

The pinnae can be affixed to the head and removed during the experimental procedure using the same Cordo material.

SUMMARY

This article briefly describes the need for and the fabrication of an artificial head model with some unique characteristics.

REFERENCES

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